

In re Patent Application of:

MOREHEAD ET AL.

Serial No. **10/661,435**

Filed: **09/12/2003**

AMENDMENTS TO THE DRAWINGS

The attached drawing sheet includes changes to Fig. 5A. This sheet replaces the original sheet including Fig. 5A and Fig. 5B.

In Figure 5A, the following change has been made:

- Reference numeral 506A without a corresponding lead line has been removed.

Attachment: Replacement Sheet

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REMARKS

Specification

In the specification, the paragraph [0067] has been amended to more clearly describe the original FIG.1.

The paragraphs [0098] and [0099] have been amended to refer to element "506A" when the original specification, due to typographic errors, referred to element "506B". The Applicants are grateful to the Examiner for pointing out this error.

Figures

Original Figure 5A erroneously included two reference numerals "506A". In amended Figure 5A, a second reference numeral "506A" has been removed.

The drawings have been objected to under 37 C.F.R. 1.121(d) because Figure 1 is thought to contain 2 lines, according to page 11 of the disclosure, while only one line is visible.

The Applicants would like to state that the drawing Figure 1 is in fact suppose to have a single line (curve), and therefore the original drawing Figure 1 is, in the Applicants' view, in adherence with 37 C.F.R. 1.121(d). The Applicants have amended the description of Figure 1 on paragraph [0067] of the Specification as published, corresponding to lines 9-11 on page 11 of the original disclosure, to make the meaning of the line (curve) shown in Figure 1 more clearly.

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Claims

Claims 1-36 are pending in this application.

Claims 1-36 have been rejected.

Claims 1-36 which have been amended as set forth above, remain in the application. Applicants respectively request reexamination.

Claims 15-22, 25, and 36 have been rejected under 35 U.S.C. 102(b), as being anticipated by Shoji et al, (Applied Physics Letters, vol. 80, no. 17 29 April 2002, by I. Shoji and T. Taira), hereafter referred to as "the Shoji paper".

Claims 1-14, 23, 26-33 and 35 have been rejected under 35 U.S.C. 102(a), as being unpatentable over Shoji in view of Grossman et al ("Grossman", US Patent 5,850,407).

Claim 24 has been rejected as being unpatentable over Shoji in view of Bowman et al ("Bowman", US Patent 6,370,1727).

Claim 34 has been rejected as being unpatentable over Shoji in view of Bowman and further in view of Grossman.

With regard to Claim 15, the applicant has amended the claim to more clearly define the claimed subject matter, and to more clearly differentiate from the cited prior art.

In particular, amended claim 15 now defines "a method for fabricating a laser or an amplifier" including the following features (a) and (b):

(a) providing, as a gain medium, a crystal characterized by a crystalline orientation such that a <100> plane of the crystal is oriented substantially perpendicular with respect to a direction of beam propagation within the crystal; ... and

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(b) wherein a cross-sectional overlap between a beam of radiation propagating through the crystal and the pumped region is greater than about 20% of a cross-sectional area of the pumped region for providing enhanced pumping efficiency.

The Applicants contend that Shoji in his paper does not teach or suggest making a laser or an amplifier using a <100> oriented YAG rod.

In particular, nowhere in the paper does Shoji teach a method of making a laser or an amplifier which includes the combination of the above-referenced features (a) and (b) as recited in the amended claim 15.

Therefore, the Applicants believe that the current invention, as defined by the Amended claim 15, is not anticipated by Shoji or by any other known prior art, and is therefore patentable.

The Applicants also contend that it would not be obvious to one skilled in the art to combine Shoji's teaching, as disclosed in his paper, with other known prior art, to provide the method for fabricating a laser or an amplifier as defined in the amended claim 15.

In Figure 4, which is referred to by the Examiner, Shoji merely illustrates various depolarization regimes for a beam propagating in YAG rods depending on their crystallographic orientation, when the beam radius is equal to the rod radius. This figure by itself is not instructive in making a laser or an optical amplifier; fabricating a commercially viable laser requires simultaneous optimization of many parameters not

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adequately represented in FIG.4. Therefore, one skilled in the art of laser design would not be immediately compelled, after seeing FIGs.4 and after reading the rest of the Shoji paper, to fabricate a laser having a $\langle 100 \rangle$ -cut laser crystal.

In fact, Shoji in his paper teaches away from the method of the instant invention for fabricating a laser or an amplifier having the aforecited features (a) and (b) of Claim 15, by emphasizing that a different crystal orientation, namely the $\langle 110 \rangle$ orientation, is capable of providing a much stronger reduction of depolarization than the $\langle 100 \rangle$ orientation, provided that the beam cross-section is small enough, as illustrated in FIG.5. It is the $\langle 110 \rangle$ orientation that Shoji suggests to use in lasers for reducing the depolarization, as is evident from the title of Shoji's paper (emphasis added):

"Intrinsic Reduction of the Depolarization Loss in Solid-State Lasers by use of a $\langle 110 \rangle$ -cut $Y_3Al_5O_{12}$ Crystal".

Shoji in his paper does not disclose any criteria, other than depolarization loss, for selecting a crystal orientation when fabricating a laser. Therefore, one skilled in the art, after reading the Shoji paper, would be compelled to fabricate a laser that uses the $\langle 110 \rangle$ cut laser crystal, for achieving a maximal reduction of the depolarization loss as taught by Shoji in his paper.

The Applicants however contend that Shoji, in emphasizing the perceived usefulness of the $\langle 110 \rangle$ crystal orientation and small beams in lasers for reducing the depolarization, fails to

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adequately address the pumping efficiency, which is an important laser characteristic.

Disadvantageously, the small beam requirement put forth in the Shoji paper would typically lead to a substantially reduced pumping efficiency, which is not addressed in the Shoji paper. Contrary to the method of the present invention as defined by the above-stated feature (b) of the amended claim 15, Shoji teaches making the laser beam sufficiently small, e.g. having a radius as small as one quarter of the rod radius, so that the perceived usefulness of the $\langle 110 \rangle$ orientation can be realized in lasers.

In contrast to the teachings of the Shoji paper, the amended Claim 15 defines a method of laser fabrication, wherein *"a cross-sectional overlap between a beam of radiation propagating through the crystal and the pumped region is greater than about 20% of a cross-sectional area of the pumped region, for providing an enhanced pumping efficiency"*, and, simultaneously, *"wherein the use of the substantially $\langle 100 \rangle$ -oriented crystal reduces depolarization loss or thermal lensing"*.

The Applicants therefore believe that amended claim 15 defines novel and inventive features that have not been disclosed by Shoji or any other known prior art, and is therefore patentable.

Dependent Claims 16-25.

The Applicants believe that the claims 16-25, which depend on the amended Claim 15, are patentable for the reasons put

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forth in reference to the amended Claim 15, in view of Shoji and other cited prior art.

Claims 26-35

Independent claim 26, which defines *"the use in a laser or optical amplifier as a gain medium of a crystal characterized by an orientation such that a <100> plane of the crystal is oriented substantially perpendicular with respect to a direction of beam propagation within the crystal"*, has been amended in a way that it now includes the amended limitation (b) as recited hereinabove with reference to the amended claim 15, and therefore should be patentable in view of Shoji for the reasons put forth hereinabove, and also in view of Grossman, who does not teach the above-stated features (a) or (b) of Claim 15.

Claims 27-35 depend on the amended claim 26, and should also be patentable.

Claims 1-14

Claims 1-14 have been rejected under 35 U.S.C. 103(a), as being unpatentable over Shoji in view of Grossman et al ("Grossman", US Patent 5,850,407).

Claim 1, which defines a laser comprising *"an optically resonant cavity defined by two or more reflecting surfaces; a substantially <100>-oriented crystal disposed within the cavity...; and, a pump source configured to provide pumping energy to a pumped region of the crystal"*, has been amended to include the amended limitation (b) of Claim 15, stated above. The Applicants believe that the amended claim 1 should be

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patentable in view of Shoji and other cited prior art for reasons put forth in reference to the amended claim 15.

Claims 2-13 are dependent on the amended claim 1 and should be patentable as long as the amended claim 1 is patentable.

Claim 36, which defines *"an optical amplifier, comprising a gain medium in the form of a crystal characterized by an orientation such that a <100> plane of the crystal is oriented substantially perpendicular with respect to a direction of beam propagation within the crystal"*, has been amended similarly to claims 1, 15 and 26 to include the aforecited amended limitation (b) of Claim 15, and should therefore be allowable for the same reasons that have been put forth hereinabove with reference to the amended claims 15 and 1.

Summarizing, the present invention, as claimed in amended claims 1, 15, 26 and 36, and the claims dependent thereupon, define a laser, an amplifier, and related methods having important novel and inventive feature - *the use of the substantially <100>-oriented crystal for reducing depolarization loss or thermal lensing, in combination with the large cross-sectional overlap between the beam and the pumped region greater than about 20% for providing enhanced pumping efficiency* - which is not disclosed or suggested in any of the prior art cited by the Examiner.

The combination of the prior art documents cited by the examiner does not yield the claimed invention, which therefore could not be considered obvious to a person skilled in the art at the time the invention was made.

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The Applicants therefore believe that the instant invention, as claimed by the amended claims 1, 15, 26 and 36, and the claims dependent thereupon, is patentable in view of the prior art cited by the Examiner and other known prior art.

In view of the aforegiven arguments, the Applicants respectfully request reconsideration of this application.

Applicants request confirmation of consideration of the IDS previously mailed to the U.S. Patent and Trademark Office on 12 September 2003.

Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned patent agent at the telephone number listed below.

Please charge any shortage in fees due in connection with the filing of this paper, including Extension of Time fees, to Deposit Account No. 50-1465 and please credit any excess fees to such deposit account.

Respectfully submitted,



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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: MAIL STOP AMENDMENT, COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450, on this 19 day of October, 2005.

Murphy